NASA STTR 2012 Phase I Solicitation

T15 Cross-cutting Aeronautics

A strong national program of research and development (R&D) for aeronautics technology forms the foundation of the U.S. aeronautics and aviation enterprise. Aeronautics R&D is critical for national security and homeland defense, an efficient national air transportation system, and the economic well-being and quality of life of our citizens. The National Aeronautics Research and Development Plan (Plan) lays out high-priority national aeronautics R&D challenges, goals, and supporting objectives to guide the conduct of U.S. The Plan includes an important new goal regarding the integration of unmanned aircraft systems into the National Airspace System. In addition, this R&D Plan:

- Supports the coordinated efforts of the Federal departments and agencies in the pursuit of stable and long-term foundational research.
- Ensures U.S. technological leadership in aeronautics for national security and homeland defense capabilities.
- Advances aeronautics research to improve aviation safety, air transportation, and reduce the environmental impacts of aviation.
- Promotes the advancement of fuel efficiency and energy independence in the aviation sector.
- Spurs the development of innovative technologies that enable new products and services.

Most of the R&D goals and objectives will require stable and long-term foundational research across a breadth of aeronautics disciplines to provide the underlying basis for new technological advances and breakthroughs. Such foundational research is often cross-cutting, resulting in technology advances that have applications across several Principles Moreover, new ideas and technologies that are generated by foundational research will help inform future updates to the National Aeronautics Research and Development Plan.

Subtopics

T15.01 Cross cutting Avionics for Beyond Earth Orbit Space Exploration

Lead Center: JSC

Participating Center(s): KSC, MSFC

As NASA human exploration and science missions move further from Earth and become increasingly more complex, they present unique challenges to the on-board avionics systems. Avionics systems in space vehicles are significant size, weight and power (SWaP) as well as cost drivers. Future destinations such as L2, near-earth asteroid, Mars, etc. are characterized by long durations, vast distances and harsh environments and call for significant advances in on-board processing, autonomy, reliability, fault-tolerance and redundancy. Advanced technologies and approaches to avionics systems and its components are needed to support these challenging mission requirements and to safely bring crew back to Earth.

Avionics provides cross- capabilities across different sub-systems and is a prime candidate for commonality between different missions and programs leading to savings in the design, development and testing, logistics (sparing, reuse, and re-purposing of hardware) and operational costs.

To support exploration mission objectives and requirements, advances in emerging avionics technologies (processors, networks and network devices, memory cards, human interfaces including visual, tactile and auditory interfaces, etc.) and associated foundational technology are required. Areas addressing miniaturization, radiation and extreme temperature environments such as radiation hardened by design, Rad-hard extreme temperature technology, and electronics packaging, etc. are of particular interest.

The focus of this subtopic is to support the development and advancement of cost-effective avionics technologies while keeping a unified approach to promote commonality of systems between multiple missions and/or programs. The ultimate goal is to develop a common avionics framework and a catalog of components that can be integrated into a space vehicle in the next 6-10 years.

T15.02 Autonomous Systems for Atmospheric Flight

Lead Center: LaRC

Participating Center(s): KSC

With increasing levels of automation capabilities in the aviation arena, provides unique opportunities and challenges for civil aviation, and the aerial transport communities. Flight will be transformed as these capabilities mature and evolve in to integrated systems. In particular, autonomous and robotic, manned and unmanned civil aircraft systems will lead to a plethora of new markets, vehicle, and missions. These new systems with broad range of capabilities, and a huge diversity of shapes and sizes, must safely utilize the future National Airspace System. Both operational and machine autonomy will require tremendous breakthroughs through the new technology frontiers in machine intelligence, autonomy, robotics, and inter-connections of these technologies. Breakthroughs in these areas could lead to such societal capabilities as autonomous cargo carrying, surveillance, air taxis, small unmanned civil aircraft, Zip aircraft, on-demand VTOL aviation, airborne wind energy platforms and a host of other emerging distributed aviation systems.

The goal of this topic area is to develop technologies and capabilities that will lead to fully autonomous systems that are able to learn and adapt to changes in their environment that were not predicted, and yet still accomplish

the mission goals, with minimal or no human involvement required.

For purposes of this solicitation, autonomous vehicles have varying levels of autonomy and range from automated capability to fully autonomous flight where the system has the ability to learn, reason, and adapt. Military applications have demonstrated the ability to do automated flight but their use in civil aviation requires additional research and development. The primary interest of this sub-topic is to advance the technologies for robotic and autonomous vehicle perception, cognition, as well as system integration. Proposals should be written around one of the following themes described below:

- Autonomous or robotic pilot - Autonomous systems can be applied far beyond remotely piloted aircraft. Maximum machine effectiveness can only be realized through vehicle autonomous systems ability to learn, reason and adapt. Current practice is to have a reliance on stored information, which is complemented by GPS position information. If there is an on-board, real-time means to sense and react to the local environment (including air and ground features and traffic), then autonomous and robotic air-vehicle can be fully utilized. But addressing how adaptive systems can still be 'trusted' in critical flight environments and achieve FAA certification is a technical issue that must be resolved. Proposals are sought to develop innovate approaches and enabling technologies for autonomous, robotic, and embodied intelligent air-vehicles. Example scenarios could include but are not limited to carrying passengers and cargo through the NAS, search, rescue, and surveillance operations, and sentries to patrol coastal waters, and land borders. Proposal should consider perception, cognition, as well as GPS enabled, GPS-denied, and cooperating and non-cooperating traffic environments.

- Autonomy for flight, the robotic test pilot. Adaptive and robust controllers designed to autonomously fly and optimize around multiple vehicles. Products would be aerodynamic coefficients such as coefficient of lift and drag as well as controller effectiveness.

- Autonomous intelligence, surveillance and reconnaissance. A next generation system would entail a "smart payload" with a UAS designed around it to accomplish specific missions. Example missions might include, but are not limited to disaster relieve, fire monitoring, launch vehicle tracking, or hurricane tracking. The payload would ultimately permit autonomous target acquisition, tracking, and aircraft attitude/orientation to optimize data collection, or ensuring mission completion. Initial activities would include an assessment of current technology capabilities that could be compared to requirements for a next generation autonomously controlled sensor and platform system to identify technology gaps and lay out a technology development road map. Subsequent activities would include component and system developments and integration in accordance with the road map, leading to the development of a prototype system capable of integrating with a UAS.